CLAIMS

1. A method of predicting a fuel injector tip temperature (FITT) in an engine, comprising the steps of:

estimating an initial temperature of the fuel injector tip;

calculating a steady state temperature of the fuel injector tip;

determining a filter coefficient as a function of a rate of airflow into the engine; and

predicting the FITT as a function of the initial temperature and the steady state temperature, wherein the steady state temperature is filtered into the FITT at a rate determined by the filter coefficient.

2. The method of claim 1 wherein the estimating step is determined as a function of a ratio between a shutdown injector temperature and a shutdown temperature of an engine coolant.

3. The method of claim 2 wherein the ratio is adjusted to decay as a function of a soak time of the engine.

4. The method of claim 3 wherein the ratio is adjusted to exponentially decay as a function of the soak time.

5. The method of claim 4 wherein the initial temperature is determined according to:

$$T_{injector\_restart} = T_{coolant\_restart}\left(1-\left(1-\frac{T_{injector\_shutdown}}{T_{coolant\_shutdown}}\right)e^{-K(Time_{soak})}\right)$$

wherein K is a constant, $T_{injector\_restart}$ is the initial temperature, $T_{coolant\_restart}$ is a temperature of the engine coolant at restart, $T_{injector\_shutdown}$ is the shutdown injector temperature, $T_{coolant\_shutdown}$ is the shutdown temperature of the engine coolant, and $Time_{soak}$ is the soak time.

6. The method of claim 1 wherein the steady state temperature is calculated as a function of at least an engine coolant temperature and an air temperature.

7. The method of claim 6 wherein the steady state temperature is calculated as a weighted average.

8. The method of claim 7 wherein the weighted average is offset by an offset value determined as a function of exhaust gas flow.

9. The method of claim 1 wherein the predicting step comprises filtering the steady state temperature into the FITT with a lag filter at a rate determined by the filter coefficient.

10. The method of claim 9 wherein the predicting step comprises providing a feedback value of the FITT to the lag filter.

11. The method of claim 1 further comprising the step of triggering a hot restart purge (HRP) if the predicted temperature exceeds a pre-determined threshold value.

12. A method of predicting a fuel injector tip temperature (FITT) in an engine, the method comprising the steps of:

calculating a steady state temperature of the fuel injector tip as a function of at least an air temperature and a current temperature of an engine coolant;

determining a filter coefficient as a function of a rate of airflow into the engine; and

predicting the FITT by filtering the steady state temperature into the FITT at a rate determined by the filter coefficient.

13. The method of claim 12 further comprising the step of estimating an initial temperature of the fuel injector tip as a function of a ratio between a shutdown injector temperature and a shutdown temperature of the engine coolant, wherein the ratio is adjusted as a function of a soak time of the engine.

14. The method of claim 13 wherein the predicting step comprises using the initial temperature as a first value of the FITT.

15. A method of predicting a fuel injector tip temperature (FITT) in an engine, comprising the steps of:

estimating an initial temperature of the fuel injector tip as a function of a ratio between a shutdown injector temperature and a shutdown temperature of an engine coolant, wherein the ratio is adjusted as a function of a soak time of the engine

calculating a steady state temperature of the fuel injector tip as a function of at least an air temperature and a current temperature of the engine coolant;

determining a filter coefficient as a function of a rate of airflow into the engine; and

predicting the FITT as a function of the initial temperature and the steady state temperature, wherein the steady state temperature is filtered into the FITT at a rate determined by the filter coefficient.

16. An apparatus for predicting a fuel injector tip temperature (FITT) in an engine, the apparatus comprising:

means for estimating an initial temperature of the fuel injector tip;

means for calculating a steady state temperature of the fuel injector tip;

means for determining a filter coefficient as a function of a rate of airflow into the engine; and

means for predicting the FITT as a function of the initial temperature and the steady state temperature, wherein the steady state temperature is filtered into the FITT at a rate determined by the filter coefficient.

17. An apparatus for predicting a fuel injector tip temperature (FITT) in an engine, the apparatus comprising:

a first module configured to estimate an initial temperature of the fuel injector tip;

a second module configured to calculate a steady state temperature of the fuel injector tip;

a third module configured to determine a filter coefficient as a function of a rate of airflow into the engine; and

a fourth module configured to predict the FITT as a function of the initial temperature and the steady state temperature, wherein the steady state temperature is filtered into the FITT at a rate determined by the filter coefficient.

18. A digital storage medium having computer-executable instructions stored thereon, the instructions comprising:

a first module configured to estimate an initial temperature of the fuel injector tip;

a second module configured to calculate a steady state temperature of the fuel injector tip;

a third module configured to determine a filter coefficient as a function of a rate of airflow into the engine; and

a fourth module configured to predict a fuel injector tip temperature (FITT) as a function of the initial temperature and the steady state temperature, wherein the steady state temperature is filtered into the FITT at a rate determined by the filter coefficient.

19. A vehicle having an engine, a fuel injection system for the engine having at least one fuel injector tip, and an engine controller module having a processor and a memory configured to store computer-executable instructions for the processor, wherein the instructions comprise:

an estimating module configured to estimate an initial temperature of the fuel injector tip;

a calculating module configured to calculate a steady state temperature of the fuel injector tip;

a determining module configured to determine a filter coefficient as a function of a rate of airflow into the engine; and

a predictor module configured to calculate a fuel injector tip temperature (FITT) a function of the initial temperature and the steady state temperature, wherein the steady state temperature is filtered into the FITT at a rate determined by the filter coefficient.

20. The vehicle of claim 19 further comprising hot restart purge (HRP) logic configured to receive the predicted temperature and to trigger a hot restart purge of a fuel canister if the predicted temperature exceeds a pre-determined threshold.